


## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P200401363 WO		<b>FOR FURTHER ACTION</b>		See Form PCT/PEA/416
International application No. PCT/DK2005/000196		International filing date (day/month/year) 22.03.2005		Priority date (day/month/year) 23.03.2004
International Patent Classification (IPC) or national classification and IPC INV. H01M8/22 H01M8/06 C01C1/02 B01D53/00 B01J20/00				
Applicant AMMINEX AS				
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 6 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau a total of 5 sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>				
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the report</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input checked="" type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input checked="" type="checkbox"/> Box No. VIII Certain observations on the international application</p>				
Date of submission of the demand  19.06.2006		Date of completion of this report  28.08.2006		
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016		Authorized officer  Crottaz, O  Telephone No. +31 70 340-8994		



INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**Box No. I Basis of the report**1. With regard to the **language**, this report is based on

- ☒ the international application in the language in which it was filed
- ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3(a) and 23.1(b))
  - ☐ publication of the international application (under Rule 12.4(a))
  - ☐ international preliminary examination (under Rules 55.2(a) and/or 55.3(a))

2. With regard to the **elements\*** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

**Description, Pages**

1-22 as originally filed

**Claims, Numbers**

1-20 filed with telefax on 19.06.2006

**Drawings, Sheets**

1/8 as originally filed

2/8-8/8 filed with telefax on 19.06.2006

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/DK2005/000196

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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

Novelty (N)	Yes: Claims	1-20
	No: Claims	
Inventive step (IS)	Yes: Claims	1-20
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-20
	No: Claims	

2. Citations and explanations (Rule 70.7):

**see separate sheet**

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**Box No. VII Certain defects in the international application**

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The following defects in the form or contents of the international application have been noted:

**see separate sheet**

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**Box No. VIII Certain observations on the international application**

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The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

**see separate sheet**

**INTERNATIONAL PRELIMINARY  
REPORT ON PATENTABILITY  
(SEPARATE SHEET)**

PCT/DK2005/000196

**Re Item V****Reasoned statement with regard to novelty, inventive step or industrial applicability;  
citations and explanations supporting such statement**

1. Reference is made to the following documents:

D1: US 2003/219371 A1 (AMENDOLA STEVEN C) 27 November 2003 (2003-11-27)

D2: FR-A-1 421 033 (GOUVERNEMENT DES ETATS-UNIS D'AMERIQUE  
REPRESENTE PAR L'ADMINISTRATION) 10 December 1965 (1965-12-10)

D3: LIU CHUN YI ET AL: "Ammonia Absorption on Alkaline Earth Halides as Ammonia  
Separation and Storage Procedure" BULL. CHEM. SOC. JPN.; BULLETIN OF THE  
CHEMICAL SOCIETY OF JAPAN 2004, vol. 77, no. 1, 2004, pages 123-131,  
XP002369290

2. Novelty and Inventive Step

2.1 The document D1 is regarded as being the closest prior art to the subject-matter of claim 1, and shows (the references in parentheses applying to this document) a fuel cell comprising an urea/water storage which generates ammonia. The ammonia is the directly used in a fuel cell or dissociated into hydrogen and nitrogen in a reactor and then fed to a fuel cell (see paragraphs [7]-[14], [30]-[32], [34], [39]-[42] and [47]).

The subject-matter of claim 1 differs from this known from D1 in that the ammonia is stored in solid form in an ammonia absorbing/releasing metal ammine salt and released by heating said salt.

The subject-matter of claim 1 is therefore new (Article 33(2) PCT).

The problem to be solved by the present invention may be regarded as to provide an ammonia based electric generating unit comprising a convenient and safe transportation of ammonia.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

D2 discloses the use of  $\text{AgCl}\cdot\text{NH}_3$  as a source of ammonia. However, the system is used in a device requiring minor amounts of ammonia, and is therefore not practical for using in a fuel cell system. The person skilled in the art would therefore have no incentive to combine the teaching of D2 with D1.

Alternatively, it has to be considered that D3 discloses the use of alkaline earth metal halides as ammonia absorbing and releasing substances. However, the use of these metal halides is related to ammonia separation during the low-temperature synthesis of ammonia. In D3 the ammonia is synthesized, by catalysis, in another part of the device. The person skilled in the art would therefore have no incentive to combine the teaching of D3 with D1.

Since an ammonia based electric generating unit comprising a metal ammine salt as convenient and safe transportation means of ammonia is neither common knowledge, nor rendered obvious by the combination of the available prior art an inventive step is present.

2.2 The same reasoning applies, mutatis mutandis, to the subject-matter of the corresponding independent claim 19 which therefore is also considered new and inventive.

2.3 Claims 2-18 and 20 are dependent on claims 1 or 19 and as such also meet the requirements of the PCT with respect to novelty and inventive step.

#### **Re Item VII**

##### **Certain defects in the international application**

3.1 The present application does not meet the criteria of Article 3(2) in combination with rule 5 PCT, because no "Brief Description of the Drawings" is provided.

3.2 The numbering indicated for Figs. 4-15 does not match with the numbering used in pp. 20-22 of the description where they are indicated as Figs. A-L.

#### **Re Item VIII**

##### **Certain observations on the international application**

4.1 The application does not meet the requirements of Article 6 PCT, because claim 15 is not

clear.

4.2 Claim 15 does not meet the requirements of Article 6 PCT in that the matter for which protection is sought is not clearly defined. The claim attempt to define the subject-matter in terms of the result to be achieved, which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result. Further, the terms "full balancing of the complete unit" used in said claim are vague and unclear and leave the reader in doubt as to the meaning of the technical features to which they refer, thereby rendering the definition of the subject-matter of said claim unclear, Article 6 PCT.

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**Amended Claims**

1. An electric power generating unit comprising
  - (i) an ammonia storage device in the form of a container comprising
    - 5 a solid ammonia absorbing and releasing metal salt complex of the general formula:  $M_a(NH_3)_nX_z$ , wherein M is one or more cations selected from alkali metals such as Li, Na, K or Cs, alkaline earth metals such as Mg or Ca, and transition metals such as V, Cr, Mn, Fe, Co, Ni, Cu, or Zn or combinations thereof such as NaAl, KAl,  $K_2Zn$ , CsCu, or  $K_2Fe$ , X is one or
      - 10 more anions selected from fluoride, chloride, bromide, iodide, nitrate, thiocyanate, sulphate, molybdate, and phosphate ions, a is the number of cations per salt molecule, z is the number of anions per salt molecule, and n is the coordination number of 2 to 12,
    - (ii) means for heating said container and ammonia absorbing and
      - 15 releasing salt for releasing ammonia gas and
    - (iia) a fuel cell for converting ammonia directly into electric power;  
or
    - (iib1) a reactor for dissociating ammonia into hydrogen and nitrogen and
      - 20 (iib2) a fuel cell for converting hydrogen into electric power.- 2. The electric power generating unit according to claim 1 further comprising means for adding ammonia to saturate the ammonia absorbing and releasing salt with ammonia.
- 25 3. The electric power generating unit according to claim 1, wherein said ammonia absorbing and releasing salt is  $Mg(NH_3)_6Cl_2$ .

4. The electric power generating unit according to any of claims 1-3, where the salt is in the form of a fine powder of micro crystals or located on a porous support material.
- 5 5. The electric power generating unit according to any of claims 1-3, where the means for heating is in the form of an electrical resistive heating device.
- 10 6. The electric power generating unit according to any of claims 1-3, where said means for heating is provided by a heat produced by chemical reactions.
- 15 7. The electric power generating unit according to claim 1 where the container and means for heating are a part of a micro-size electric system being micro fabricated using processes such as mechanical grinding, chemical vapour deposition (CVD), plasma enhanced chemical vapour deposition (PECVD), electron cyclotron resonance (ECR), sputtering, etching, lithographic methods such as electron beam lithography, photo lithography, or laser lithography.
- 20 8. The power generating unit according to claim 1 where the reactor for dissociating ammonia contains a heterogeneous catalyst.
- 25 9. The power generating unit according to claims 8 where said heterogeneous catalyst comprises a support and an active phase.
- 30 10. The power generating unit according to claims 9 where said active phase comprises dispersed nanoparticles of transition metals or compounds thereof such as  $\text{Co}_3\text{Mo}_3\text{N}$ , Ru, Co, Ni and Fe or mixtures thereof.



11. The power generating unit according to any of claims 1-10 further comprising a combustion device wherein a part of the hydrogen produced in the reactor, unreacted hydrogen from the fuel cell or a mixture thereof is oxidized for providing heat for heating the ammonia storage device.
- 5
12. The power generating unit according to any of claims 1-10 further comprising a combustion device wherein a fraction of the hydrogen produced in the reactor, unreacted hydrogen from the fuel cell or a mixture thereof is oxidized for providing heat for heating said reactor for dissociating ammonia.
- 10
13. The power generating unit according to any of claims 1-10 further comprising a combustion device wherein a fraction of the ammonia released from the ammonia storage, unreacted ammonia from the fuel cell or a mixture thereof is oxidized for providing heat for heating said ammonia storage device.
- 15
14. The power generating unit according to any of claims 1-10 further comprising a combustion device wherein a fraction of the ammonia released from the ammonia storage, unreacted ammonia from the fuel cell or a mixture thereof is oxidized for providing heat for heating said reactor for dissociating ammonia.
- 20
15. The power generating unit according to claims 1-14 where the constituents thereof are dimensioned to provide full balancing of the complete unit by dimensioning tubes, chambers, flows, insulation, temperatures etc. to obtain optimal output of electrical energy from the electrical power generating unit.
- 25

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16. The power generating unit according to any of claims 1-14 in the form of a micro-size power source for microelectronic devices or micro-electro-mechanical-systems (MEMS).
- 5 17. The power generating unit according to claim 1 where said reactor for dissociating ammonia is a part of a micro-size electric system being micro fabricated using processes such as mechanical grinding, chemical vapour deposition (CVD), plasma enhanced chemical vapour deposition (PECVD), electron cyclotron resonance (ECR), sputtering, etching, litho-
- 10 graphic methods such as electron beam lithography, photo lithography, or laser lithography.
18. The power generating unit according to any of claims 1-10 where the reactor for dissociating ammonia is divided into two parts, one part oper-
- 15 ated at a low temperature that dissociates most ammonia and another part operated at a high temperature that dissociates the last present fraction of ammonia.
19. The use of an ammonia storage device in the form of a container
- 20 comprising a solid ammonia absorbing and releasing metal salt complex of the general formula:  $M_a(NH_3)_nX_z$ , wherein M is one or more cations selected from alkali metals such as Li, Na, K or Cs, alkaline earth metals such as Mg or Ca, and transition metals such as V, Cr, Mn, Fe, Co, Ni, Cu, or Zn or combinations thereof such as NaAl, KAl,  $K_2Zn$ , CsCu, or  $K_2Fe$ , X
- 25 is one or more anions selected from fluoride, chloride, bromide, iodide, nitrate, thiocyanate, sulphate, molybdate, phosphate, and chlorate ions, a is the number of cations per salt molecule, z is the number of anions per salt molecule, and n is the coordination number of 2 to 12 as a source of energy in a electric power generating unit comprising

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(1) means for heating said container and ammonia absorbing and releasing salt for releasing ammonia gas,

(2a) a fuel cell for converting ammonia directly into electric power; or comprising

5 (2b1) a reactor for dissociating ammonia into hydrogen and nitrogen and

(2b2) a fuel cell for converting hydrogen into electric power.

10 20. The use according to claim 19 wherein the electric power generating unit according further comprises means for adding ammonia to saturate the ammonia absorbing and releasing salt with ammonia.

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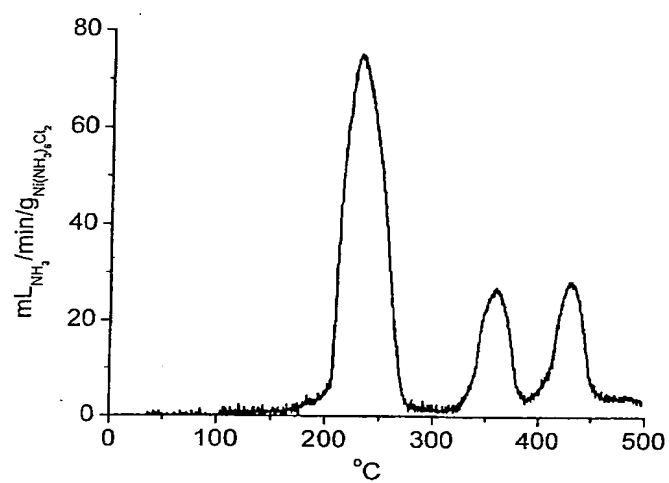
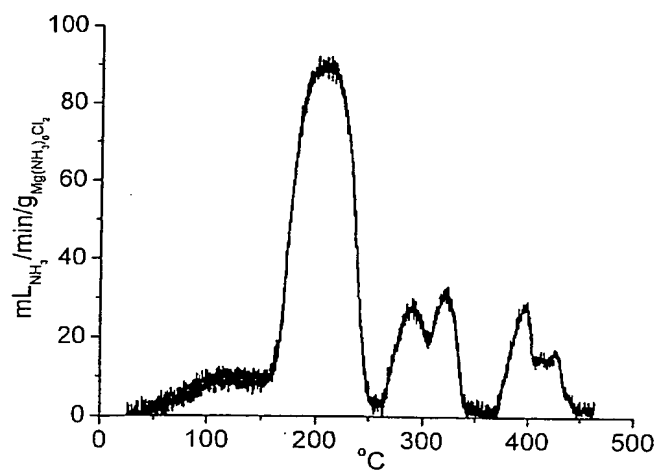
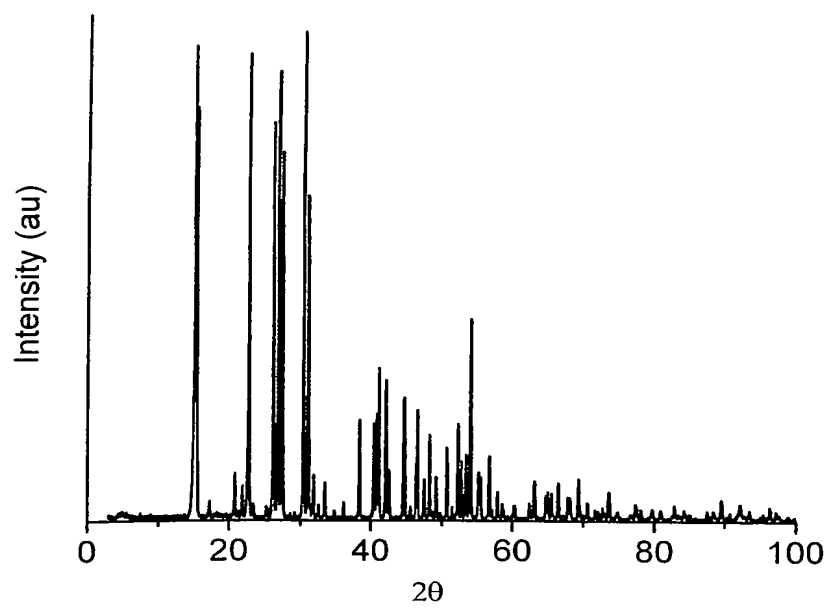
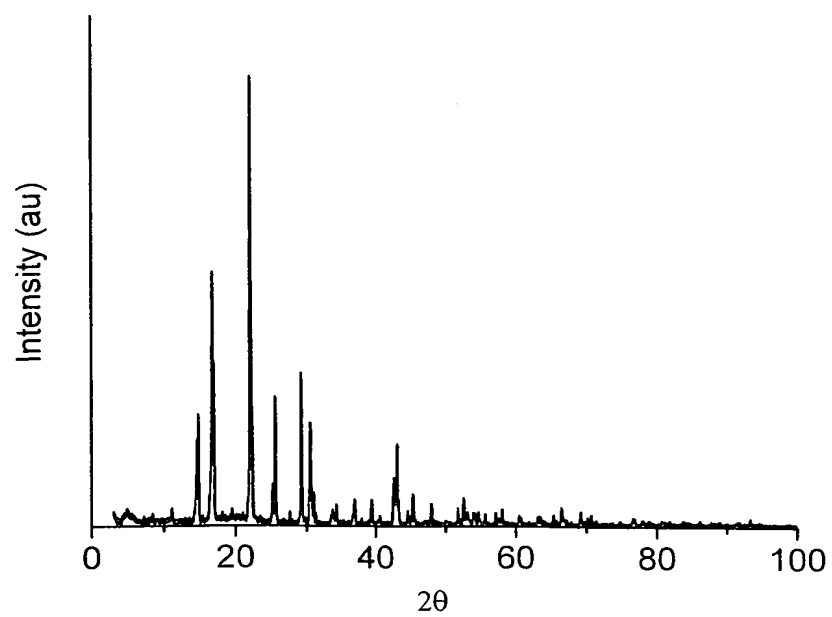
FIG. 4 NiCl<sub>2</sub>FIG. 5 MgCl<sub>2</sub>

FIG. 6  $\text{ZnCl}_2$ FIG. 7  $\text{CuSO}_4$ 

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FIG. 8 CoCl<sub>3</sub>

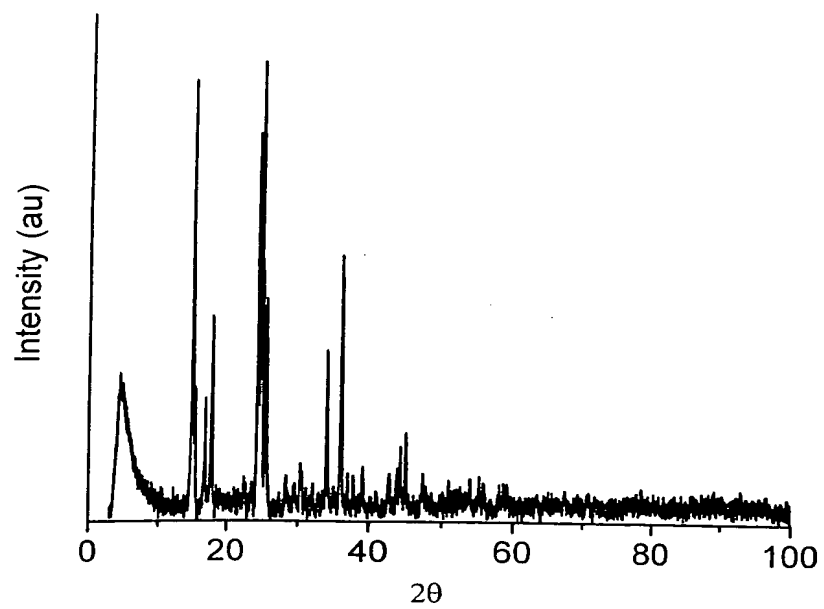


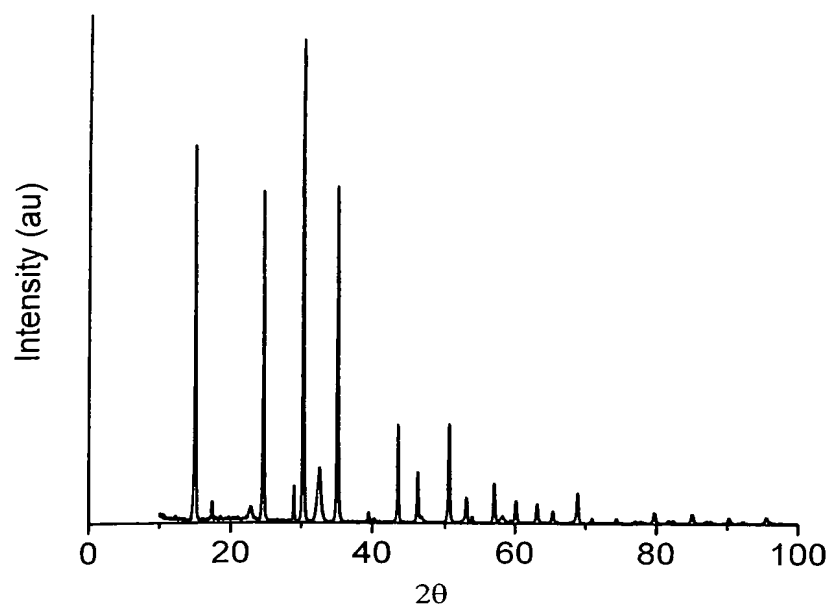
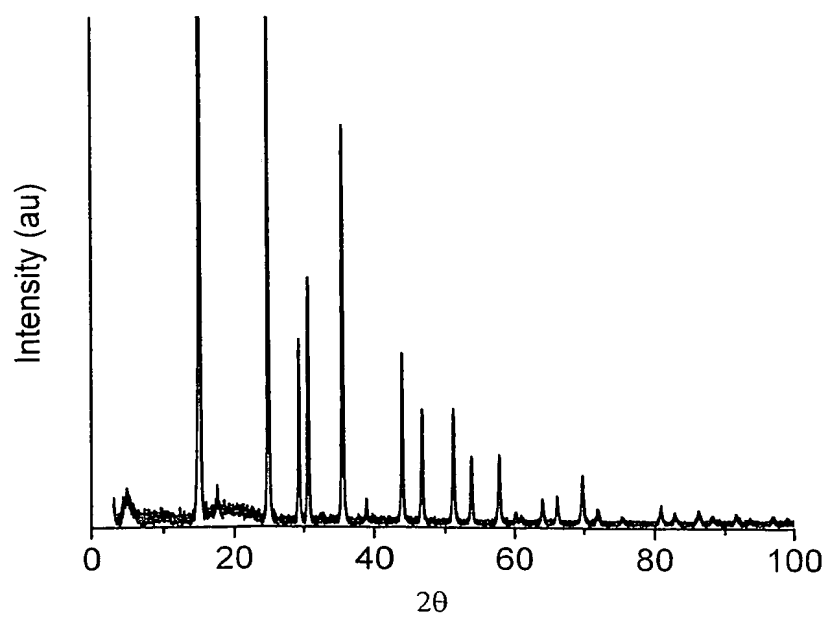
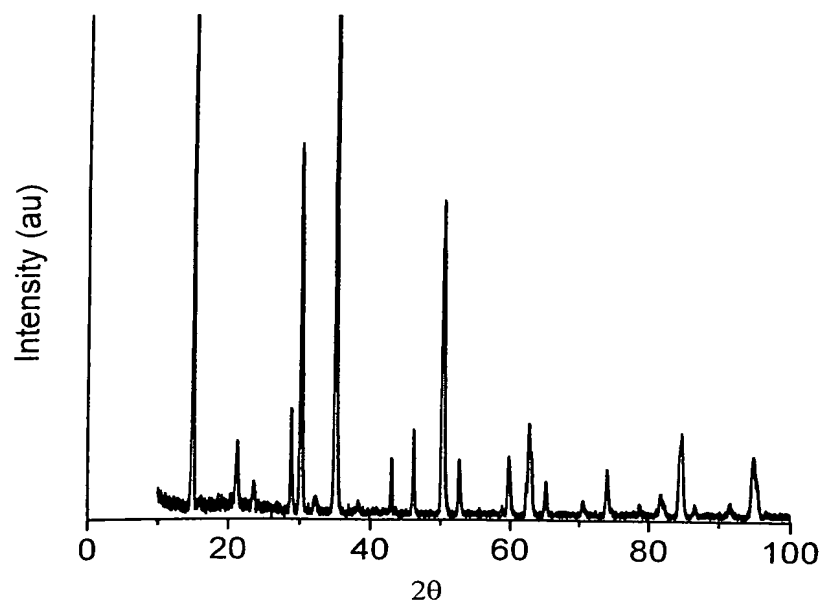
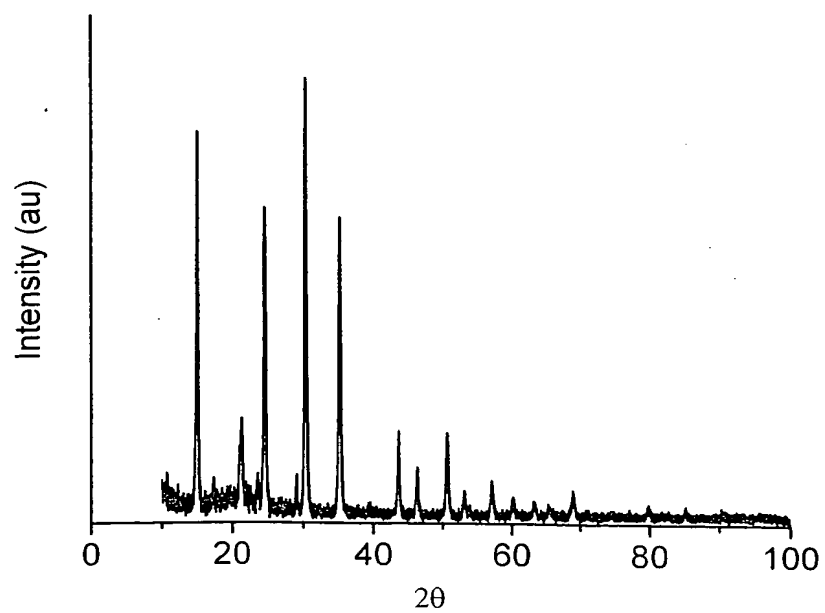
FIG. 9 MgCl<sub>2</sub> 1 absFIG. 10 NiCl<sub>2</sub> 1 abs

FIG. 11 MgCl<sub>2</sub> 1 desFIG. 12 MgCl<sub>2</sub> 2 abs



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FIG. 13

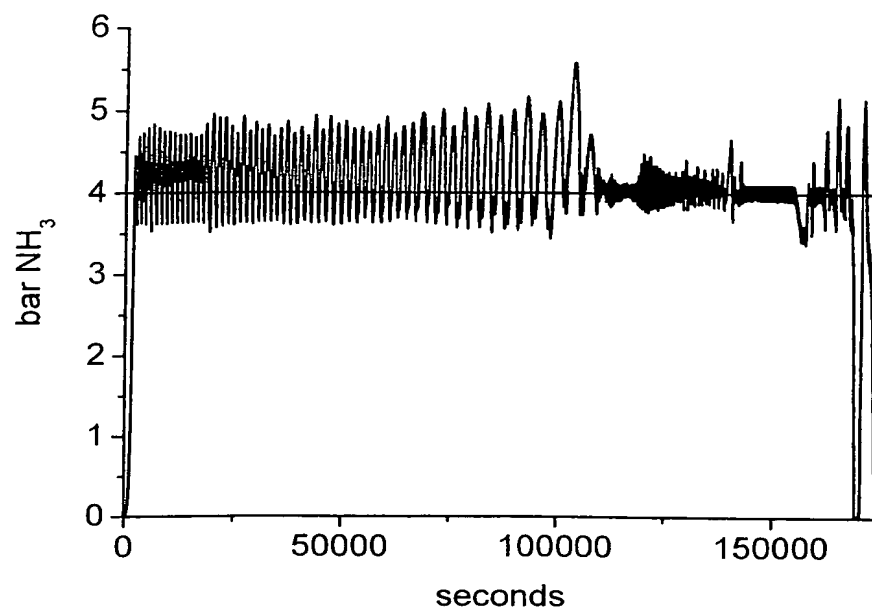


FIG. 14

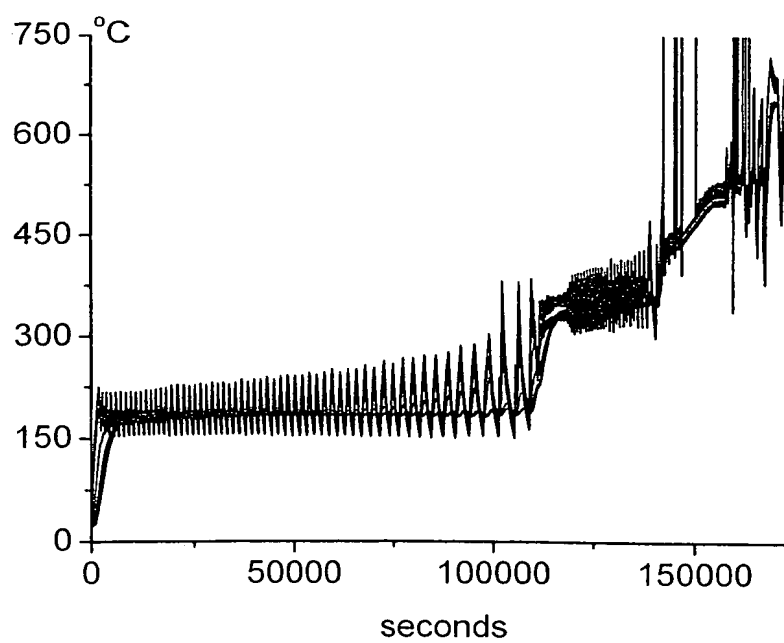
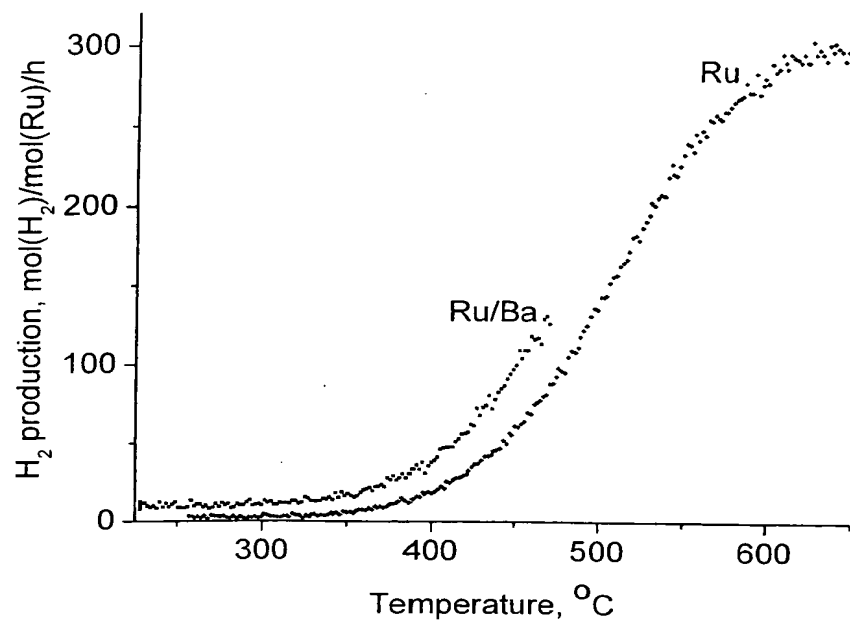


FIG. 15



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